

CLAIMS

1. A display device provided with a display element of an active matrix type comprising:

scanning signal lines for supplying thereto scanning signals from a scanning signal driver;

data signal lines for supplying thereto data signals from a data signal driver by AC driving; and

pixels connected to said scanning signal lines and said data signal lines, each of said pixels including a predetermined electric capacitance in which a charge, which determines a display state as an active element is periodically set in a selection state, is written via the active element based on a scanning signal and a data signal,

wherein each of said pixels includes an auxiliary capacitance formed with respect to the electric capacitance in such a manner that a capacitive bond is not generated between an electrode of the auxiliary capacitance and a corresponding one of said scanning signal lines,

said display device further comprising:

frequency setting means capable of setting a rewriting frequency, which determines a cycle of writing the charge, to be not more than 30 Hz.

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3. The display device as set forth in claim 1 or

2, wherein:

said rewriting frequency is within a range of from not less than 0.5 Hz to not more than 30 Hz.

4. The display device as set forth in claim 1 or 2, wherein:

said rewriting frequency is within a range of from not less than 1 Hz to not more than 15 Hz.

5. The display device as set forth in claim 1 or 2, wherein:

said frequency setting means is also capable of setting a rewriting frequency to be not less than 30 Hz.

6. The display device as set forth in claim 1 or 2, wherein:

said frequency setting means is capable of setting a plurality of frequencies for said rewriting frequency.

7. The display device as set forth in claim 6, wherein:

the plurality of frequencies for said rewriting frequency are integer multiplies of a smallest one of

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the plurality of frequencies for said rewriting frequency respectively.

8. The display device as set forth in claim 6, wherein:

the plurality of frequencies for said rewriting frequency are integer powers of the number 2 of multiples of the number 2 of a smallest rewriting frequency respectively.

9. The display device as set forth in claim 6, wherein:

at least a smallest frequency of the plurality of frequencies for said rewriting frequency is a multiple of an integer of not less than 2 of a refresh frequency for updating a display content of said display element.

10. The display device as set forth in claim 9, wherein:

upon updating the refresh frequency, said frequency setting means is capable of setting at least a smallest frequency of the plurality of frequencies for said rewriting frequency according to the refresh frequency as updated.

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11. The display device as set forth in claim 6, wherein:

a smallest frequency of the plurality of frequencies for said rewriting frequency is an integer of not less than 2 Hz.

12. The display device as set forth in claim 1 or 2, wherein:

said display element is a liquid crystal display element including an electric capacitance formed by interposing liquid crystal between a pixel electrode and a counter electrode, and an auxiliary capacitance formed corresponding to the electric capacitance, said liquid crystal display element having a pixel voltage holding ratio P satisfying the condition of:

$$V_1 = V - \{V \cdot (1 - Hr(T)) \times C_{LC} / (C_{LC} + C_{CS})\}$$

$$P = V_1 \cdot \exp[-T / \{(C_{LC} + C_{CS}) \cdot R\}] / V \geq 0.9,$$

wherein C_{LC} is the electric capacitance, C_{CS} is the auxiliary capacitance, T is a non-selective period of the active element, $Hr(T)$ is a liquid crystal voltage holding ratio after the non-selection period of T at the rewriting frequency, V is a potential difference between the pixel electrode and the counter electrode directly after writing, R is a resistance value of the active element in the non-selection period.

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13. The display device as set forth in claim 1 or 2, wherein:

said display element is a liquid crystal display element including an electric capacitance formed by interposing liquid crystal between a pixel electrode and a counter electrode,

said pixel electrode is formed so as to at least partially face a scanning signal line of pixels connected to a line adjacent, in a fixed direction along the scanning direction, to a line to which a pixel of said pixel electrode is connected.

14. The display device as set forth in claim 1 or 2, wherein:

the display element is a liquid crystal display element including an electric capacitance formed by interposing liquid crystal between a pixel electrode and a counter electrode,

wherein said pixel electrode is a non-transmissive type electrode, which is formed so as to at least partially face active elements of pixels connected to a line adjacent in a fixed direction along a scanning direction to a line to which a pixel of said electrode is connected.

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15. The display device as set forth in claim 14,
wherein:

said liquid crystal display element further includes an active element light-shielding layer for shielding active elements of one of the lines effective for display, which is formed on a starting point side in a fixed direction.

16. The display device as set forth in claim 15,
wherein:

said liquid crystal display element further includes an anti-reflected light-shielding layer for preventing a reflected light from said active element light-shielding layer from being returned onto a display surface of said liquid crystal display element.

17. The display device as set forth in claim 15,
wherein:

said active element light-shielding layer is an electrode formed in such a manner that liquid crystal is interposed between said electrode and said counter electrode, and

an AC voltage is applied between said active element light-shielding layer and said counter

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electrode,

18. The display device as set forth in claim 17, wherein:

the liquid crystal display element includes a line of pixels wherein said active element light-shielding layer is adopted as pixel electrodes, said line of pixels being formed on outer side than a line formed at an end on a starting point side in the fixed direction.

19. The display device as set forth in claim 1 or 2, wherein:

said display element is a liquid crystal display element including an electric capacitance formed by interposing liquid crystal between said pixel electrode and said counter electrode, and

said liquid crystal display element further includes a light-shielding layer formed so as to at least partially face, from a display surface side, respective sides of said pixel electrodes, positioned on a side closer to a starting point of an alignment process.

20. The display device as set forth in claim 1 or 2, wherein:

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the display element is a liquid crystal display element including an electric capacitance formed by interposing liquid crystal between a pixel electrode and a counter electrode, and

a surface in contact with a portion treated with an alignment process of said pixel electrodes, excluding an area electrically in contact with the active elements, has a level difference of not more than 0.6 μm .

21. The display device as set forth in claim 1 or 2, wherein:

said display element is a liquid crystal display element having an electric capacitance formed by interposing liquid crystal between a pixel electrode and a counter electrode, and

a portion around respective sides of said pixel electrodes, positions on a side closer to a starting point of an alignment process is constituted by a transparent electrode.

22. The display device as set forth in claim 1 or 2, wherein:

said display element is a liquid crystal display element including an electric capacitance formed by

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interposing liquid crystal between a pixel electrode and a counter electrode,

wherein a direction of applying an alignment treatment to a substrate on the side active elements are formed is substantially parallel to the scanning signal lines.

23. The display device as set forth in claim 12, wherein:

said liquid crystal display element includes a reflective member which realizes a reflective-type display using surrounding light.

24. The display device as set forth in claim 23, wherein:

said reflective member constitutes at least a part of said pixel electrode.

25. The display device as set forth in claim 24, wherein:

said reflective member either has a hole for transmitting therethrough light or is semi-transparent.

26. An electronic device adopting said display device of claim 1 or 2.

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wherein a quiescent period, in which all the scanning signal lines are set in non-scanning state, is set to be longer than a scanning period required for scanning the screen one time, wherein a sum of the scanning period and the quiescent period is set to be equivalent to one vertical period.

a non-scanning period including the quiescent period is selected among a plurality of non-scanning periods.

$$(T1 + T02) = (T1 + T01) \times N \text{ (N is an integer of not less than 2),}$$

wherein T1 is the scanning period, T01 is the

shortest one of the plurality of said non-scanning periods, and T02 is a non-scanning period other than T01.

30. The method of driving a display device as set forth in claim 27,

said display device includes image data storage means for storing image data based on which the data signal is produced, and

an operation of transferring the image data from said image data storage means is stopped in the quiescent period.

31. The method of driving a display device as set forth in claim 27, wherein:

said display device includes image data supply means for supplying image data based on which the data signal is produced, and

an operation of receiving a supply of the image data from said image data supply means is stopped in the quiescent period.

32. The method of driving a display device as set forth in claim 27, wherein:

an operation of an analog circuit irrelevant to

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display is stopped in said quiescent period.

33. The method of driving a display device as set forth in claim 32, wherein:

an operation of at least an analog circuit of said data signal line driver is stopped in the quiescent period.

34. The method of driving a display device as set forth in claim 27, wherein:

said data signal lines are all set in high-impedance state with respect to at least said data signal driver for driving all of said data signal lines in the quiescent period.

35. The method of driving a display device as set forth in claim 34, wherein:

in said quiescent period, after setting said data signal lines all in high-impedance state, an operation of an analog circuit irrelevant to display is stopped.

36. The method of driving a display device as set forth in claim 35, wherein:

in said quiescent period, an operation of at least an analog circuit of said data signal driver is

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stopped.

37. The method of driving a display device as set forth in claim 34, wherein:

said data signal lines are all set in high impedance state after setting them to have potential at which variation in data holding state of all the pixels are minimized on average.

38. A display device, comprising:

control means for executing said method of driving a display device of claim 27.

39. An electronic device adopting the display device of claim 38.

40. The method of driving a display device of claim 27, wherein:

said display device is a liquid crystal display device which includes a liquid crystal display element having pixels arranged in a matrix form in which a charge based on a data signal supplied through the data signal line is written periodically in an electric capacitance formed by interposing liquid crystal between a pixel electrode and a counter electrode via

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the active element as selected by a scanning signal to be supplied from the scanning signal line.

41. The method of driving a display device of claim 40, wherein:

a non-selective voltage which substantially maximizes an OFF resistance value of the active element is applied to all of said scanning signal lines in the quiescent period.

42. The method of driving a display device of claim 40, wherein:

said quiescent period is set within a range of from 16.7 msec to not more than 2 sec.

43. The method of driving a display device of claim 40, wherein:

said quiescent period is set within a range of from 50 msec to not more than 1 sec.

44. A display device comprising:

control means for executing the driving method of a display device of claim 40.

45. The display device of claim 44, wherein:

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said liquid crystal display element includes an auxiliary capacitance electrode which forms an auxiliary capacitance of the pixel with said pixel electrode, is formed so as not to be overlapped with said scanning signal lines.

46. The display device as set forth in claim 45, wherein said liquid crystal display element has a pixel voltage holding ratio P satisfying the following condition of:

$$V_1 = V - \{V \cdot (1 - Hr(T)) \times C_{LC} / (C_{LC} + C_{CS})\}$$

$$P = V_1 \cdot \exp[-T / \{(C_{LC} + C_{CS}) \cdot R\}] / V \geq 0.9,$$

wherein C_{LC} is an electric capacitance between the pixel electrode and the counter electrode, C_{CS} is the auxiliary capacitance, T is a non-selection period of the active element, $Hr(T)$ is a liquid crystal voltage holding ratio after the non-selection period of T at the rewriting frequency, V is a potential difference between the pixel electrode and the counter electrode directly after writing, R is a resistance value of the active element in the non-selection period.

47. The display device as set forth in claim 44, wherein:

said liquid crystal display element includes a

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reflective member which realizes a reflective-type display using surrounding light.

48. The display device as set forth in claim 47, wherein:

said reflective member constitutes at least a part of said pixel electrode.

49. The display device as set forth in claim 47, wherein:

said reflective member either has a hole for transmitting therethrough light or is semi-transmissive.

50. An electronic device adopting said display device of claim 44.

51. A method of driving a display device which displays by selecting and scanning each scanning signal line of a screen having pixels arranged in a matrix form and supplying through a data signal line a data signal to a corresponding pixel of the scanning signal line as selected, wherein:

subsequent to a scanning period required for scanning a screen one time, a quiescent period, in

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in said quiescent period, a potential of said data signal line is set to a predetermined data signal line quiescent potential.

the data signal line quiescent potential of said data signal line in the quiescent period is set within a range of a voltage of the data signal to be supplied to the data signal line in said scanning period.

the data signal line quiescent potential of said data signal line in a quiescent period is set to a center of an amplitude of a data signal to be supplied to said data signal line in said scanning period.

54. A method of driving a display device which displays by selecting and scanning each scanning signal line of a screen having pixels arranged in a matrix form and supplying through a data signal line a data

signal to a corresponding pixel of the scanning signal line as selected, wherein:

a quiescent period, in which all the scanning signal lines are set in non-scanning state, is set to be longer than a scanning period required for scanning a screen one time, and

in the quiescent period, a potential of a counter electrode is set to a predetermined counter electrode quiescent potential.

55. The method of driving a display device as set forth in claim 54, wherein:

the counter electrode quiescent potential of said counter electrode in the quiescent period is set within a range of a voltage of a counter electrode driving signal to be supplied to said counter electrode in the scanning period.

56. The method of driving a display device as set forth in claim 54, wherein:

the counter electrode quiescent potential of said counter electrode in the quiescent period is set to a center of an amplitude of the counter electrode driving signal to be supplied to said counter electrode in the scanning period.

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a potential of said data signal line in said quiescent period is fixed to the data signal line quiescent potential by said method of any one of claims 51 to 53, and

58. The method of driving a display device as set forth in claim 57, wherein:

in said quiescent period, the potential of the data signal line and the potential of the counter electrode are set to the data signal line quiescent potential and the counter electrode quiescent potential respectively, and

subsequently, said data signal line is set in high-impedance state with respect to said data signal driver for supplying data signals to said data signal lines.

59. A method of driving a display device which displays by selecting and scanning each scanning signal

line of a screen having pixels arranged in a matrix form and supplying through a data signal line a data signal to a corresponding pixel of the scanning signal line as selected, wherein:

subsequent to a scanning period required for scanning a screen one time, a quiescent period, in which all the scanning signal lines are set in non-scanning state, is formed so as to be longer than the scanning period, and

an AC driving signal, having a frequency of not more than that of the data signal to be supplied to the data signal line in the scanning period, is applied to the data signal line in the quiescent period.

60. The method of driving a display device as set forth in claim 59, wherein:

an amplitude of a driving signal to be applied to the data signal line in said quiescent period is set within a range of a voltage of a data signal to be supplied to the data signal line in the scanning period.

61. A method of driving a display device which displays by selecting and scanning each scanning signal line of a screen having pixels arranged in a matrix

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both of said driving signals have identical frequencies and phases.

an AC driving signal, which is within a range of a voltage of a counter electrode driving signal to be supplied to said counter electrode in the scanning period and which has a frequency of not more than that of the counter electrode driving signal, is applied to the said counter electrode and said data signal line in the quiescent period.

subsequent to a scanning period required for

scanning a screen one time, a quiescent period, in which all the scanning signal lines are set in non-scanning state, is formed so as to be longer than the scanning period, and

a DC driving signal, having a potential within a range of a voltage of a counter electrode driving signal to be applied to said counter electrode in the scanning period, is applied to said counter electrode and the data signal line in the quiescent period.

65. A display device comprising control means which executes the driving method of the display device of any one of claims 51, 54, 59, 61, 63 and 64.

66. An electronic device mounting the display device of claim 65.

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